



## Research Article

### EFFECT OF CRY TOXINS ON LENGTH AND WIDTH OF TOBACCO CATERPILLAR, *Spodoptera litura* (FAB.)

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**Abstract-** Laboratory experiment was conducted during Kharif-2013 to evaluate the effect of the Cry toxins (Cry1Ac+Cry2Ab) against Tobacco caterpillar, *Spodoptera litura* (Fab.). For this eleven Bollgard-II cotton hybrids and one non Bt cotton were grown in the field. The leaves, squares and bolls which were collected (Periodically at 60, 75, 90 and 125 DAS) from the field were taken to the lab. On those plant parts different instars (first, second, third and fourth instar) of *S. litura* were reared in the laboratory conditions to know the effect of Cry toxin on the length and width of the *S. litura* larvae. The length and width of the larvae were decreased in BG-II reared larvae then non BT. Hence, the cry toxins showed a significant effect on the length and width of the *S. litura* larvae. Within the instars also the effect of Cry toxins were more on the first, second and third instar larvae when compared to the fourth instar larvae.

**Keywords:** Bollgard-II, Cry toxins, length and width, *S. litura*

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#### Introduction

Cotton (*Gossypium spp.*), the king of fibers, is also called as white gold, enjoys a predominant position among the cash crops in the world and India as well. Transgenic cotton is currently grown on 25 million hectares around the world, mostly in India, China, Pakistan and the US [1]. India continued to maintain the largest area under cotton and second largest producer of cotton next to China with 34 per cent of world area and 21 per cent of world production. These are under cultivation of Bt cotton in India was around 11.7 million ha, production 356.10 lakh bales with productivity of 496.39 kg ha<sup>-1</sup>. In India, the area under cultivation was highest in Maharashtra with 41.46 lakh ha, followed by Gujarat (24 lakhha) and Andhra Pradesh (22.69 lakh ha). Production and productivity of cotton in Andhra Pradesh was 72.00 lakh bales and 506.96 kg ha<sup>-1</sup>, respectively [2].

More than 162 species of insect pests attack different stages of cotton [3]. Among them, bollworms are the most destructive pests and reduce the yield in India. About 54 per cent of the total insecticides used in Indian agriculture are sprayed on cotton crop. This indicates the economic importance of bollworms in cotton cultivation [4].

Realizing the economic importance of cotton bollworms, MAHYCO (Maharashtra Hybrid Seed Company), introduced first transgenic cotton containing Cry 1 Ac toxic to lepidopteran pests was approved for commercial utilization in Australia and USA in 1996. Transgenic cottons which produce *B. thuringiensis* toxin have been shown to be effective against many lepidopteran pests in the field and laboratory [5-6]. But *S. litura* larva was not controlled by first generation Bt cotton (BG-I). Then, second generation (BG-II) Bt genotypes with Cry 1 Ac + Cry 2 Ab have been developed in 2006 by Monsanto private limited, USA ([www.indiagminfo.org](http://www.indiagminfo.org)). The Cry 2 Ab protein present in Bollgard-II cotton cultivars improves control of these insects compared to Bollgard-I [7-8]. This article reports the results of laboratory assays with a dual toxin Bt cotton cultivars compared with non Bt.

#### Materials and Methods

Laboratory studies regarding the length and width of *S. litura* on eleven BG-II cotton hybrids were conducted at Bt Lab, Department of Entomology, College of Agriculture, Rajendranagar, Hyderabad during Kharif-2013. The experiment was conducted with first four larval instars i.e., first, second, third and fourth instars of *S. litura* by feeding on leaves, squares and bolls of different BG-II cotton hybrids belonging to eleven BG-II cotton hybrids viz., Ankur-3034, Ajeet-155, Chetak, ATM, Bhakti, Brahma, Denim, Rasi-665, Rasi-668, Sudarshan, Yuva and non Bt cotton as control.

Larvae were collected from the field were reared on the natural diet i.e., castor leaves up to pupation and the adults released from the pupae were kept for oviposition in cages. Subsequent instars were maintained on natural diet.

The eleven BG-II cotton hybrids were maintained in the college farm, college of Agriculture, Rajendranagar. The plots were maintained with all agronomic practices including the herbicide application also.

The length and width of the *S. litura* larvae were studied individually by exposing to leaves, squares and bolls of Ankur-3034, Ajeet-155, Chetak, ATM, Bhakti, Brahma, Denim, Rasi-665, Rasi-668, Sudarshan, Yuva and non Bt cotton as control with twelve treatments and three replication at 60, 75, 90 and 125 days old crop. The plant parts were replaced daily with fresh Bt plant parts to avoid death or growth reduction due to tissue drying or nutritional deterioration.

The experiment was conducted in a completely randomized block design (CRD) with three replications @ five larvae per replication (three replications). Length and width of the surviving larvae was recorded after seven days of exposure. By using the ocular micrometer the larval length and width were recorded. The stage and ocular micrometers were set in microscope and the value of one ocular division was calibrated.

$$\text{One ocular division} = \frac{\text{No. of divisions on stage micrometer}}{\text{No. of divisions on ocular micrometer}} \times 10$$

## Treatments

Instars/treatments	First Instar	Second Instar	Third Instar	Fourth Instar
Treatments (Eleven BG-II hybrids)	Leaves (60, 75, 90 and 125 DAS)	Leaves (60, 75, 90 and 125 DAS)	Leaves (60, 75, 90 and 125 DAS)	Leaves (60, 75, 90 and 125 DAS)
	Squares (60, 75, 90 and 125 DAS)	Squares (60, 75, 90 and 125 DAS)	Squares (60, 75, 90 and 125 DAS)	Squares (60, 75, 90 and 125 DAS)
		Bolls (90 and 125 DAS)	Bolls (90 and 125 DAS)	Bolls (90 and 125 DAS)
Control (Non Bt cotton)	Leaves (60, 75, 90 and 125 DAS)	Leaves (60, 75, 90 and 125 DAS)	Leaves (60, 75, 90 and 125 DAS)	Leaves (60, 75, 90 and 125 DAS)
	Squares (60, 75, 90 and 125 DAS)	Squares (60, 75, 90 and 125 DAS)	Squares (60, 75, 90 and 125 DAS)	Squares (60, 75, 90 and 125 DAS)

## Results and Discussion

The length and width of *S. litura* larvae was observed instars wise on leaves, squares and bolls of eleven BG-II cotton hybrids viz., Ankur-3034, Ajeet-155, Chetak, ATM, Bhakti, Brahma, Denim, Rasi-665, Rasi-668, Sudarshan, Yuva and non Bt cotton as control at 60, 75, 90 and 125 days old crop. Different parameters viz., larval length and width were studied and presented here under.

Effect of BG-II and non-Bt cotton on larval length of *S. litura* Leaves

The length of second instar larvae fed with leaves of eleven BG-II cotton hybrids at 60, 75, 90 and 125 DAS recorded and ranged in between 0.72-1.19, 0.69-1.18, 0.67-1.14 and 0.43-0.99 cm, respectively. In case of the third instar larval length which were fed with leaves of eleven BG-II cotton hybrids at 60, 75, 90 and 125 DAS ranged in between 1.52-2.17, 1.47-1.92, 1.54-2.07 and 1.34-1.78 cm, respectively. Whereas, the length of the fourth instar larvae fed with leaves of eleven BG-II cotton hybrids recorded at 60, 75, 90 and 125 DAS ranged in between 1.94-2.53, 2.00-2.48, 1.97-2.45 and 1.88-2.28 cm, respectively [Table-1]. On leaves the minimum length of the second, third and fourth instar larvae of *S. litura* was recorded as 0.43, 1.51 and 1.88 cm on Rasi-665 hybrid in between 60 and 125 DAS at seven days after release. The length of first, second, third and fourth instar larvae of *S. litura* fed with leaves recorded lowest on Rasi-665, among all the eleven BG-II cotton hybrids. The length of second, third and fourth instar larvae on BG-II cotton hybrid leaves were significantly different from non-Bt cotton. But, there was no significant difference between the treatments. These observations were similar with the results of [9], where the second instar larval length of *S. exigua* at six days after infestation was 0.77 cm on BG-II cotton hybrid, on non-Bt the recorded length was 1.67 cm. [10] recorded the length of the first, second, third and fourth instar larvae immediately after moulting of the larvae on BG-II cotton hybrid was 0.17, 0.23, 0.4 and 1.49 cm. The length of the larvae on BG-II was decreased drastically when compared to non-Bt. These findings are in line with the results of [10].

Table-1 Effect of test hybrid leaves on larval length of *S. litura*.

Treatments	Length of second instar larvae (cm)				Length of third instar larvae (cm)				Length of fourth instar larvae (cm)			
	60 DAS	75 DAS	90 DAS	125 DAS	60 DAS	75 DAS	90 DAS	125 DAS	60 DAS	75 DAS	90 DAS	125 DAS
Ankur-3034	1.14 (1.45) <sup>bc</sup>	0.86 (1.37) <sup>f</sup>	1.02 (1.42) <sup>cd</sup>	0.99 (1.41) <sup>b</sup>	2.17 (1.78) <sup>a</sup>	1.72 (1.65) <sup>b</sup>	1.72 (1.65) <sup>e</sup>	1.65 (1.63) <sup>bc</sup>	2.29 (1.81) <sup>d</sup>	2.17 (1.78) <sup>c</sup>	2.33 (1.83) <sup>c</sup>	2.18 (1.78) <sup>c</sup>
Ajeet-155	1.19 (1.47) <sup>b</sup>	1.18 (1.48) <sup>a</sup>	0.99 (1.41) <sup>d</sup>	0.99 (1.41) <sup>b</sup>	2.11 (1.76) <sup>bc</sup>	1.92 (1.71) <sup>a</sup>	1.88 (1.70) <sup>c</sup>	1.78 (1.67) <sup>a</sup>	2.53 (1.88) <sup>a</sup>	2.48 (1.87) <sup>a</sup>	2.3 (1.82) <sup>c</sup>	2.21 (1.79) <sup>c</sup>
Chetak	1.18 (1.45) <sup>b</sup>	0.98 (1.41) <sup>cd</sup>	0.98 (1.41) <sup>d</sup>	0.99 (1.41) <sup>b</sup>	2.09 (1.76) <sup>bc</sup>	1.56 (1.60) <sup>efg</sup>	1.9 (1.70) <sup>b</sup> c	1.67 (1.64) <sup>b</sup>	2.53 (1.88) <sup>a</sup>	2.32 (1.82) <sup>b</sup>	2.45 (1.86) <sup>a</sup>	2.28 (1.81) <sup>b</sup>
ATM	0.89 (1.31) <sup>e</sup>	0.72 (1.31) <sup>gh</sup>	0.86 (1.36) <sup>e</sup>	0.89 (1.38) <sup>c</sup>	2.12 (1.77) <sup>abc</sup>	1.71 (1.65) <sup>b</sup>	2.02 (1.74) <sup>a</sup>	1.34 (1.53) <sup>e</sup>	2.52 (1.88) <sup>a</sup>	2.45 (1.86) <sup>a</sup>	2.12 (1.77) <sup>d</sup>	2.12 (1.77) <sup>d</sup>
Bhakti	0.89 (1.37) <sup>e</sup>	1.09 (1.44) <sup>b</sup>	1.00 (1.42) <sup>d</sup>	0.78 (1.33) <sup>d</sup>	1.96 (1.72) <sup>d</sup>	1.59 (1.61) <sup>ef</sup>	1.95 (1.72) <sup>b</sup>	1.70 (1.64) <sup>b</sup>	2.42 (1.85) <sup>b</sup>	2.16 (1.78) <sup>cd</sup>	2.39 (1.84) <sup>b</sup>	1.92 (1.71) <sup>f</sup>
Brahma	1.01 (1.42) <sup>d</sup>	0.92 (1.39) <sup>e</sup>	1.06 (1.44) <sup>bc</sup>	0.75 (1.32) <sup>d</sup>	1.93 (1.71) <sup>de</sup>	1.67 (1.63) <sup>bc</sup>	2.07 (1.75) <sup>a</sup>	1.77 (1.66) <sup>a</sup>	2.43 (1.85) <sup>b</sup>	2.18 (1.78) <sup>c</sup>	2.40 (1.85) <sup>ab</sup>	2.23 (1.80) <sup>bc</sup>
Denim	1.09 (1.45) <sup>c</sup>	0.97 (1.41) <sup>de</sup>	1.14 (1.47) <sup>a</sup>	0.53 (1.24) <sup>e</sup>	2.08 (1.75) <sup>c</sup>	1.54 (1.59) <sup>fg</sup>	1.91 (1.71) <sup>b</sup> c	1.76 (1.66) <sup>a</sup>	2.49 (1.87) <sup>a</sup>	2.49 (1.87) <sup>a</sup>	2.10 (1.76) <sup>de</sup>	2.03 (1.74) <sup>e</sup>
Rasi-665	0.72 (1.48) <sup>js</sup>	0.69 (1.30) <sup>h</sup>	0.67 (1.30) <sup>js</sup>	0.43 (1.20) <sup>i</sup>	1.52 (1.59) <sup>f</sup>	1.52 (1.58) <sup>gh</sup>	1.54 (1.59) <sup>f</sup>	1.51 (1.58) <sup>d</sup>	1.94 (1.72) <sup>e</sup>	2.00 (1.73) <sup>e</sup>	1.97 (1.72) <sup>f</sup>	1.88 (1.70) <sup>f</sup>
Rasi-668	0.83 (1.35) <sup>f</sup>	0.77 (1.33) <sup>g</sup>	0.91 (1.39) <sup>e</sup>	0.53 (1.24) <sup>e</sup>	1.88 (1.70) <sup>e</sup>	1.47 (1.57) <sup>h</sup>	1.56 (1.60) <sup>f</sup>	1.61 (1.60) <sup>c</sup>	2.42 (1.85) <sup>b</sup>	2.11 (1.76) <sup>d</sup>	2.33 (1.82) <sup>c</sup>	2.02 (1.73) <sup>e</sup>
Sudarshan	1.18 (1.21) <sup>b</sup>	0.85 (1.36) <sup>f</sup>	0.90 (1.38) <sup>e</sup>	0.55 (1.25) <sup>e</sup>	1.89 (1.70) <sup>e</sup>	1.60 (1.61) <sup>de</sup>	1.80 (1.67) <sup>d</sup>	1.78 (1.67) <sup>a</sup>	2.34 (1.83) <sup>cd</sup>	2.18 (1.78) <sup>c</sup>	2.10 (1.76) <sup>de</sup>	2.18 (1.78) <sup>c</sup>
Yuva	0.76 (1.40) <sup>js</sup>	0.77 (1.33) <sup>g</sup>	0.77 (1.30) <sup>f</sup>	0.51 (1.23) <sup>e</sup>	1.57 (1.60) <sup>f</sup>	1.67 (1.64) <sup>bc</sup>	1.82 (1.68) <sup>d</sup>	1.48 (1.57) <sup>d</sup>	2.39 (1.84) <sup>bc</sup>	2.30 (1.82) <sup>b</sup>	2.06 (1.75) <sup>e</sup>	2.18 (1.78) <sup>c</sup>
Control	1.58 (1.64) <sup>a</sup>	1.03 (1.43) <sup>c</sup>	1.10 (1.45) <sup>ab</sup>	1.38 (1.54) <sup>a</sup>	2.14 (1.77) <sup>ab</sup>	1.65 (1.63) <sup>cd</sup>	2.04 (1.74) <sup>a</sup>	1.61 (1.62) <sup>c</sup>	2.54 (1.88) <sup>a</sup>	2.46 (1.86) <sup>a</sup>	2.32 (1.82) <sup>c</sup>	2.4 (1.84) <sup>a</sup>
CD	0.06	0.042	0.05	0.028	0.076	0.036	0.06	N.S.	0.058	0.057	0.06	0.033
SE(m)	0.02	0.014	0.02	0.01	0.026	0.012	0.02	0.03	0.02	0.019	0.02	0.011

Figures in parentheses are square root transformed values; numbers followed by same superscript are not statistically different. \*first instar recorded 100 per cent mortality on BG-II cotton leaves.

## Squares

The length of first instar larvae fed with squares of eleven BG-II cotton hybrids at 60, 75, 90 and 125 DAS ranged in between 0.38-0.54, 0.29-0.55, 0.39-0.76, 0.26-0.39 cm, respectively [Table-2]. In case of second instar larvae the length at 60, 75, 90 and 125 DAS ranged in between 0.64-1.19, 0.64-1.10, 0.79-1.20, 0.66-1.24 cm, respectively [Table-2]. The length of third instar larvae fed with squares of eleven BG-II cotton hybrids at 60, 75, 90 and 125 DAS ranged in between 1.55-2.03, 1.49-1.95, 1.58-1.99 and 1.48-2.01 cm, respectively [Table-3]. The length of

fourth instar larvae fed with squares of eleven BG-II cotton hybrids at 60, 75, 90 and 125 DAS ranged in between 1.88-2.35, 1.90-2.34, 1.97-2.36 and 2.11-2.38 cm, respectively [Table-3].

On squares the minimum length of first, second, third and fourth instar larvae of *S. litura* was recorded as 0.26, 0.65, 1.48 and 1.88 cm on Rasi-665 BG-II hybrid in between 60 and 125 DAS at seven days after release. The different instars fed on squares exhibited similar trend in length and width as those fed on leaves. That means there was a decrease in the length and width of the larvae reared on BG-II

cotton hybrids compared to non Bt cotton. But when compared to leaves and squares, the length of the larvae on squares was decreased. The reason for inhibiting growth on squares was Cry protein content. The findings obtained are

similar with the findings of [11] where Bt spray formulations inhibited the growth and feeding of *S. litura* larvae but application of Cry 1 Ac separately did not influence on the behaviour of these insects.

**Table-2** Effect of test hybrid squares on length of first and second instar larvae of *S. litura*.

Treatments	Length of first instar larvae (cm)				Length of second instar larvae (cm)			
	60 DAS	75 DAS	90 DAS	125 DAS	60 DAS	75 DAS	90 DAS	125 DAS
Ankur-3034	0.54 (1.24) <sup>b</sup>	0.54 (1.24) <sup>b</sup>	0.76 (1.33) <sup>b</sup>	0.36 (1.17) <sup>bc</sup>	1.05 (1.43) <sup>c</sup>	1.08 (1.44) <sup>bc</sup>	1.10 (1.45) <sup>b</sup>	1.05 (1.43) <sup>c</sup>
Ajeet-155	0.47 (1.21) <sup>c</sup>	0.55 (1.25) <sup>b</sup>	0.61 (1.27) <sup>d</sup>	0.32 (1.15) <sup>cd</sup>	1.19 (1.47) <sup>b</sup>	1.1 (1.41) <sup>b</sup>	1.20 (1.48) <sup>a</sup>	1.24 (1.50) <sup>b</sup>
Chetak	0.40 (1.22) <sup>de</sup>	0.46 (1.21) <sup>c</sup>	0.47 (1.21) <sup>fg</sup>	0.32 (1.15) <sup>cd</sup>	1.06 (1.44) <sup>c</sup>	1.03 (1.42) <sup>c</sup>	1.09 (1.44) <sup>bc</sup>	1.05 (1.43) <sup>c</sup>
ATM	0.43 (1.20) <sup>cde</sup>	0.38 (1.18) <sup>d</sup>	0.44 (1.20) <sup>gh</sup>	0.34 (1.16) <sup>bc</sup>	0.85 (1.36) <sup>f</sup>	0.88 (1.37) <sup>e</sup>	1.04 (1.43) <sup>cd</sup>	0.96 (1.40) <sup>d</sup>
Bhakti	0.43 (1.20) <sup>cde</sup>	0.47 (1.21) <sup>c</sup>	0.39 (1.18) <sup>h</sup>	0.27 (1.13) <sup>d</sup>	0.90 (1.38) <sup>ef</sup>	0.94 (1.39) <sup>d</sup>	0.88 (1.37) <sup>ef</sup>	0.84 (1.36) <sup>e</sup>
Brahma	0.47 (1.21) <sup>c</sup>	0.47 (1.21) <sup>c</sup>	0.72 (1.31) <sup>bc</sup>	0.31 (1.15) <sup>cd</sup>	0.95 (1.40) <sup>de</sup>	0.95 (1.40) <sup>d</sup>	1.06 (1.43) <sup>bc</sup>	0.74 (1.32) <sup>g</sup>
Denim	0.48 (1.22) <sup>c</sup>	0.48 (1.22) <sup>c</sup>	0.51 (1.23) <sup>ef</sup>	0.32 (1.15) <sup>cd</sup>	0.92 (1.39) <sup>e</sup>	0.94 (1.39) <sup>d</sup>	0.99 (1.41) <sup>d</sup>	0.76 (1.33) <sup>g</sup>
Rasi-665	0.38 (1.18) <sup>e</sup>	0.30 (1.14) <sup>e</sup>	0.43 (1.19) <sup>gh</sup>	0.26 (1.12) <sup>d</sup>	0.65 (1.477) <sup>g</sup>	0.83 (1.35) <sup>ef</sup>	0.92 (1.39) <sup>e</sup>	0.67 (1.29) <sup>h</sup>
Rasi-668	0.44 (1.20) <sup>cd</sup>	0.29 (1.13) <sup>e</sup>	0.45 (1.20) <sup>g</sup>	0.3 (1.14) <sup>cd</sup>	0.64 (1.28) <sup>g</sup>	0.64 (1.28) <sup>g</sup>	0.79 (1.34) <sup>g</sup>	0.66 (1.29) <sup>h</sup>
Sudarshan	0.46 (1.21) <sup>c</sup>	0.46 (1.21) <sup>c</sup>	0.69 (1.30) <sup>c</sup>	0.39 (1.18) <sup>b</sup>	0.65 (1.29) <sup>g</sup>	0.87 (1.37) <sup>ef</sup>	0.89 (1.38) <sup>ef</sup>	0.68 (1.30) <sup>h</sup>
Yuva	0.44 (1.20) <sup>cd</sup>	0.48 (1.22) <sup>c</sup>	0.54 (1.24) <sup>e</sup>	0.34 (1.16) <sup>bc</sup>	0.98 (1.28) <sup>d</sup>	0.82 (1.35) <sup>f</sup>	0.86 (1.36) <sup>f</sup>	0.81 (1.34) <sup>ef</sup>
Control	0.86 (1.34) <sup>a</sup>	0.98 (1.40) <sup>a</sup>	0.91 (1.38) <sup>a</sup>	1.06 (1.43) <sup>a</sup>	1.44 (1.40) <sup>a</sup>	1.41 (1.55) <sup>a</sup>	1.25 (1.50) <sup>a</sup>	1.40 (1.55) <sup>a</sup>
CD	0.03	0.04	0.05	0.10	0.06	0.05	0.05	0.03
SE(m)	0.009	0.01	0.02	0.033	0.02	0.018	0.02	0.01

Figures in parentheses are square root transformed values; numbers followed by same superscript are not statistically different

**Table-3** Effect of test hybrid squares on length of third and fourth instar larvae of *S. litura*.

f	Length of third instar larvae (cm)				Length of fourth instar larvae (cm)			
	60 DAS	75 DAS	90 DAS	125 DAS	60 DAS	75 DAS	90 DAS	125 DAS
Ankur-3034	1.84 (1.68) <sup>c</sup>	1.78 (1.66) <sup>de</sup>	1.86 (1.69) <sup>de</sup>	1.94 (1.69) <sup>b</sup>	2.22 (1.79) <sup>de</sup>	2.2 (1.79) <sup>d</sup>	2.31 (1.82) <sup>b</sup>	2.33 (1.83) <sup>bc</sup>
Ajeet-155	2.03 (1.74) <sup>b</sup>	1.95 (1.72) <sup>b</sup>	1.99 (1.73) <sup>b</sup>	2.01 (1.73) <sup>a</sup>	2.28 (1.81) <sup>bc</sup>	2.34 (1.83) <sup>bc</sup>	2.36 (1.83) <sup>b</sup>	2.38 (1.84) <sup>b</sup>
Chetak	1.72 (1.65) <sup>d</sup>	1.93 (1.71) <sup>cd</sup>	1.91 (1.71) <sup>cd</sup>	1.86 (1.69) <sup>cd</sup>	2.33 (1.83) <sup>ab</sup>	2.31 (1.82) <sup>c</sup>	2.14 (1.77) <sup>cd</sup>	2.23 (1.80) <sup>d</sup>
ATM	1.83 (1.68) <sup>c</sup>	1.85 (1.69) <sup>d</sup>	1.88 (1.69) <sup>d</sup>	1.95 (1.66) <sup>b</sup>	2.19 (1.79) <sup>e</sup>	2.17 (1.78) <sup>de</sup>	2.18 (1.78) <sup>c</sup>	2.34 (1.83) <sup>bc</sup>
Bhakti	1.70 (1.64) <sup>d</sup>	1.74 (1.65) <sup>e</sup>	1.81 (1.68) <sup>e</sup>	1.90 (1.70) <sup>bc</sup>	2.08 (1.75) <sup>f</sup>	2.13 (1.77) <sup>e</sup>	2.14 (1.77) <sup>cd</sup>	2.32 (1.82) <sup>c</sup>
Brahma	1.62 (1.62) <sup>e</sup>	1.78 (1.66) <sup>e</sup>	1.81 (1.68) <sup>e</sup>	1.84 (1.68) <sup>d</sup>	2.35 (1.83) <sup>a</sup>	2.40 (1.84) <sup>a</sup>	2.04 (1.74) <sup>f</sup>	2.36 (1.83) <sup>bc</sup>
Denim	1.58 (1.60) <sup>ef</sup>	1.84 (1.69) <sup>bc</sup>	1.95 (1.72) <sup>bc</sup>	1.81 (1.57) <sup>d</sup>	1.91 (1.71) <sup>g</sup>	1.96 (1.72) <sup>a</sup>	2.08 (1.75) <sup>ef</sup>	2.31 (1.82) <sup>c</sup>
Rasi-665	1.55 (1.61) <sup>f</sup>	1.49 (1.58) <sup>g</sup>	1.58 (1.61) <sup>g</sup>	1.48 (1.54) <sup>f</sup>	1.88 (1.69) <sup>g</sup>	1.90 (1.70) <sup>h</sup>	2.10 (1.76) <sup>de</sup>	2.21 (1.79) <sup>d</sup>
Rasi-668	1.61 (1.61) <sup>e</sup>	1.69 (1.63) <sup>f</sup>	1.72 (1.64) <sup>f</sup>	1.48 (1.54) <sup>f</sup>	2.27 (1.81) <sup>cd</sup>	1.94 (1.72) <sup>gh</sup>	1.97 (1.72) <sup>g</sup>	2.11 (1.76) <sup>e</sup>
Sudarshan	1.71 (1.65) <sup>d</sup>	1.71 (1.65) <sup>f</sup>	1.69 (1.64) <sup>f</sup>	1.83 (1.71) <sup>d</sup>	2.10 (1.76) <sup>f</sup>	2.05 (1.75) <sup>f</sup>	2.12 (1.76) <sup>de</sup>	2.25 (1.80) <sup>d</sup>
Yuva	1.60 (1.61) <sup>ef</sup>	1.63 (1.62) <sup>g</sup>	1.63 (1.62) <sup>g</sup>	1.68 (1.63) <sup>e</sup>	2.08 (1.76) <sup>f</sup>	2.02 (1.74) <sup>f</sup>	2.10 (1.76) <sup>de</sup>	2.33 (1.83) <sup>bc</sup>
Control	2.12 (1.77) <sup>a</sup>	1.86 (1.69) <sup>a</sup>	2.11 (1.76) <sup>a</sup>	1.93 (1.66) <sup>b</sup>	2.31 (1.82) <sup>abc</sup>	2.38 (1.84) <sup>ab</sup>	2.53 (1.88) <sup>a</sup>	2.60 (1.90) <sup>a</sup>
CD	0.06	0.03	0.03	0.04	0.07	0.04	0.04	0.04
SE(m)	0.02	0.01	0.02	0.01	0.03	0.02	0.01	0.01

Figures in parentheses are square root transformed values; numbers followed by same superscript are not statistically different

### Bolls

In case of second instar larvae the length at 90 and 125 DAS ranged in between 0.65-1.12 and 0.43-1.15 cm, respectively. The length of third instar larvae fed with bolls of eleven BG-II cotton hybrids recorded at 90 and 125 DAS ranged in between 1.44-2.06, 1.53-2.03 cm, respectively. The length of fourth instar larvae fed with bolls of eleven BG-II cotton hybrids at 90 and 125 DAS ranged in between

1.92-2.44, 2.43-3.12 cm, respectively [Table-4].

Minimum length of *S. litura* second instar larvae fed on bolls was 0.43 cm on Denim at 125 DAS, third instar was 1.44 cm on Rasi-665 at 90 DAS and fourth instar was 2.06 cm on Rasi-665 at 90 DAS. The length of the larvae on bolls was increased compared to squares and leaves. This may be due to the expression of Cry toxin was less in bolls. Hence, the growth of the larvae increased on bolls.

**Effect of BG-II cotton and non-Bt cotton on larval width of *S. litura*****Leaves**

The width of the second instar larvae at 60, 75, 90 and 125 DAS ranged in between 0.04-0.08, 0.04-0.08, 0.05-0.08 and 0.05-0.08 cm, respectively. The width of the third instar larvae fed with leaves of eleven BG-II cotton hybrids recorded at 60, 75, 90 and 125 DAS ranged in between 0.15-0.19, 0.13-0.18, 0.15-0.25, 0.14-0.22 cm, respectively. The width of the fourth instar larvae fed with

leaves of eleven BG-II cotton hybrids at 60, 75, 90 and 125 DAS ranged in between 0.33-0.48, 0.34-0.44, 0.33-0.53, 0.28-0.44 cm, respectively [Table-5].

On leaves the minimum mean width (60, 75, 90 and 125 DAS) of the second, third and fourth instar larvae of *S. litura* was 0.04, 0.13 and 0.28 cm on Rasi-665 BG-II cotton hybrid. The width was decreased from 60 to 90 DAS. Whereas, width increased in later stages of the crop. But the results were deviated in some hybrids like Sudarshan, Yuva, Rasi-665 and Rasi-668.

**Table-4** Effect of test hybrid bolls on larval length of *S. litura*.

Treatments	Length of second instar larvae (cm)		Length of third instar larvae (cm)		Length of fourth instar larvae (cm)	
	90 DAS	125 DAS	90 DAS	125 DAS	90 DAS	125 DAS
Ankur-3034	0.67 (1.29)f	1.09 (1.45)c	1.44 (1.56)h	1.88 (1.70)cd	2.38 (1.83)c	2.52 (1.88)ef
Ajeet-155	1.06 (1.43)b	1.15 (1.47)b	1.62 (1.62)f	2.03 (1.74)a	2.44 (1.85)b	3.12 (2.03)b
Chetak	0.82 (1.34)e	1.01 (1.42)d	1.79 (1.67)cd	1.88 (1.69)cd	2.22 (1.79)d	2.55 (1.88)de
ATM	0.90 (1.38)d	1.07 (1.44)c	1.67 (1.63)ef	1.76 (1.66)e	1.92 (1.71)g	2.71 (1.93)c
Bhakti	0.98 (1.41)c	0.92 (1.39)e	1.71 (1.64)e	1.94 (1.72)b	2.13 (1.77)e	2.49 (1.87)fg
Brahma	0.93 (1.39)cd	0.77 (1.33)f	1.7 (1.64)e	1.91 (1.72)bc	2.22 (1.79)d	2.59 (1.90)d
Denim	0.65 (1.28)f	0.43 (1.20)i	1.44 (1.56)h	1.53 (1.59)g	2.06 (1.74)f	2.35 (1.83)i
Rasi-665	1.12 (1.45)a	0.69 (1.30)g	2.06 (1.74)b	1.84 (1.68)d	2.4 (1.84)bc	2.43 (1.85)h
Rasi-668	0.92 (1.38)d	0.72 (1.31)fg	1.84 (1.69)c	1.75 (1.66)e	2.38 (1.84)c	2.43 (1.85)h
Sudarshan	0.93 (1.39)cd	0.47 (1.21)i	1.77 (1.66)d	1.86 (1.69)cd	2.41 (1.85)bc	2.76 (1.94)c
Yuva	0.81 (1.35)e	0.54 (1.24)h	1.54 (1.60)g	1.74 (1.66)e	2.10 (1.76)ef	2.46 (1.85)gh
Control	1.17 (1.48)a	1.21 (1.48)a	2.13 (1.77)a	1.65 (1.63)f	2.53 (1.88)a	3.21 (2.05)a
CD	0.05	0.04	0.05	0.03	0.02	0.12
SE(m)	0.02	0.02	0.02	0.01	0.01	0.04

Figures in parentheses are square root transformed values; numbers followed by same superscript are not statistically different

**Table-5** Effect of test hybrid leaves on larval width of *S. litura*.

Treatments	Width of second instar larvae (cm)				Width of third instar larvae (cm)				Width of fourth instar larvae (cm)			
	60 DAS	75 DAS	90 DAS	125 DAS	60 DAS	75 DAS	90 DAS	125 DAS	60 DAS	75 DAS	90 DAS	125 DAS
Ankur-3034	0.08 (1.04) <sup>a</sup>	0.07 (1.03) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.08 (1.04) <sup>a</sup>	0.18 (1.09) <sup>a</sup>	0.18 (1.09) <sup>a</sup>	0.16 (1.08) <sup>a</sup>	0.17 (1.08) <sup>a</sup>	0.36 (1.17) <sup>ab</sup>	0.34 (1.16) <sup>a</sup>	0.38 (1.17) <sup>a</sup>	0.29 (1.14) <sup>a</sup>
Ajeet-155	0.07 (1.04) <sup>a</sup>	0.07 (1.03) <sup>a</sup>	0.08 (1.04) <sup>a</sup>	0.07 (1.03) <sup>a</sup>	0.19 (1.09) <sup>a</sup>	0.17 (1.08) <sup>a</sup>	0.25 (1.12) <sup>a</sup>	0.22 (1.11) <sup>a</sup>	0.48 (1.21) <sup>ab</sup>	0.44 (1.20) <sup>a</sup>	0.53 (1.23) <sup>a</sup>	0.42 (1.20) <sup>a</sup>
Chetak	0.06 (1.03) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.07 (1.04) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.16 (1.08) <sup>a</sup>	0.17 (1.08) <sup>a</sup>	0.24 (1.11) <sup>a</sup>	0.18 (1.09) <sup>a</sup>	0.41 (1.18) <sup>ab</sup>	0.40 (1.18) <sup>a</sup>	0.44 (1.20) <sup>a</sup>	0.39 (1.18) <sup>a</sup>
ATM	0.05 (1.03) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.16 (1.08) <sup>a</sup>	0.15 (1.07) <sup>a</sup>	0.17 (1.09) <sup>a</sup>	0.16 (1.08) <sup>a</sup>	0.38 (1.17) <sup>b</sup>	0.30 (1.14) <sup>a</sup>	0.34 (1.16) <sup>a</sup>	0.29 (1.14) <sup>a</sup>
Bhakti	0.08 (1.04) <sup>a</sup>	0.08 (1.04) <sup>a</sup>	0.08 (1.04) <sup>a</sup>	0.05 (1.03) <sup>a</sup>	0.15 (1.07) <sup>a</sup>	0.16 (1.07) <sup>a</sup>	0.21 (1.10) <sup>a</sup>	0.19 (1.09) <sup>a</sup>	0.41 (1.19) <sup>ab</sup>	0.40 (1.18) <sup>a</sup>	0.41 (1.19) <sup>a</sup>	0.33 (1.16) <sup>a</sup>
Brahma	0.07 (1.04) <sup>a</sup>	0.08 (1.03) <sup>a</sup>	0.08 (1.04) <sup>a</sup>	0.08 (1.04) <sup>a</sup>	0.18 (1.09) <sup>a</sup>	0.16 (1.08) <sup>a</sup>	0.19 (1.10) <sup>a</sup>	0.17 (1.08) <sup>a</sup>	0.42 (1.19) <sup>ab</sup>	0.38 (1.18) <sup>a</sup>	0.50 (1.23) <sup>a</sup>	0.42 (1.20) <sup>a</sup>
Denim	0.08 (1.04) <sup>a</sup>	0.07 (1.02) <sup>a</sup>	0.07 (1.03) <sup>a</sup>	0.07 (1.03) <sup>a</sup>	0.17 (1.08) <sup>a</sup>	0.18 (1.09) <sup>a</sup>	0.21 (1.10) <sup>a</sup>	0.18 (1.09) <sup>a</sup>	0.33 (1.16) <sup>a</sup>	0.45 (1.20) <sup>a</sup>	0.52 (1.23) <sup>a</sup>	0.30 (1.14) <sup>a</sup>
Rasi-665	0.04 (1.02) <sup>a</sup>	0.04 (1.03) <sup>a</sup>	0.05 (1.03) <sup>a</sup>	0.05 (1.02) <sup>a</sup>	0.15 (1.07) <sup>a</sup>	0.13 (1.06) <sup>a</sup>	0.15 (1.07) <sup>a</sup>	0.14 (1.07) <sup>a</sup>	0.33 (1.16) <sup>a</sup>	0.35 (1.16) <sup>a</sup>	0.33 (1.15) <sup>a</sup>	0.28 (1.13) <sup>a</sup>
Rasi-668	0.07 (1.04) <sup>a</sup>	0.05 (1.03) <sup>a</sup>	0.07 (1.03) <sup>a</sup>	0.05 (1.02) <sup>a</sup>	0.15 (1.07) <sup>a</sup>	0.14 (1.07) <sup>a</sup>	0.21 (1.10) <sup>a</sup>	0.19 (1.10) <sup>a</sup>	0.41 (1.19) <sup>ab</sup>	0.38 (1.18) <sup>a</sup>	0.41 (1.19) <sup>a</sup>	0.30 (1.14) <sup>a</sup>
Sudarshan	0.08 (1.04) <sup>a</sup>	0.05 (1.03) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.19 (1.09) <sup>a</sup>	0.13 (1.06) <sup>a</sup>	0.18 (1.08) <sup>a</sup>	0.17 (1.08) <sup>a</sup>	0.47 (1.21) <sup>ab</sup>	0.44 (1.20) <sup>a</sup>	0.36 (1.17) <sup>a</sup>	0.44 (1.20) <sup>a</sup>
Yuva	0.08 (1.04) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.08 (1.04) <sup>a</sup>	0.07 (1.03) <sup>a</sup>	0.16 (1.08) <sup>a</sup>	0.15 (1.07) <sup>a</sup>	0.20 (1.10) <sup>a</sup>	0.16 (1.08) <sup>a</sup>	0.47 (1.21) <sup>ab</sup>	0.41 (1.19) <sup>a</sup>	0.38 (1.17) <sup>a</sup>	0.44 (1.20) <sup>a</sup>
Control	0.06 (1.03) <sup>a</sup>	0.07 (1.03) <sup>a</sup>	0.08 (1.04) <sup>a</sup>	0.07 (1.03) <sup>a</sup>	0.18 (1.09) <sup>a</sup>	0.17 (1.08) <sup>a</sup>	0.24 (1.11) <sup>a</sup>	0.22 (1.10) <sup>a</sup>	0.55 (1.25) <sup>a</sup>	0.48 (1.22) <sup>a</sup>	0.47 (1.22) <sup>a</sup>	0.47 (1.21) <sup>a</sup>
CD	0.01	0	0.01	0.004	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.04
SE(m)	0.004	0	0.003	0.001	0.01	0	0.003	0.004	0.01	0.01	0	0.012

Figures in parentheses are square root transformed values; numbers followed by same superscript are not statistically different.\* First instar recorded 100 per cent mortality on BG-II cotton leaves.

### Squares

The width of first instar larvae fed with squares of eleven BG-II cotton hybrids at 60, 75, 90 and 125 DAS ranged in between 0.03-0.07, 0.03-0.05, 0.04-0.06 and 0.03-0.04 cm, respectively [Table-6]. The width of second instar larvae at 60, 75, 90 and 125 DAS ranged in between 0.06-0.09, 0.05-0.10, 0.06-0.12, 0.05-0.09 cm, respectively [Table-6]. The width of third instar larvae fed with squares of eleven BG-II cotton hybrids recorded at 60, 75, 90 and 125 DAS ranged in between 0.13-0.22, 0.12-0.25, 0.12-0.28 and 0.15-0.27 cm, respectively. The width of fourth instar larvae fed with squares of eleven BG-II cotton hybrids were recorded at 60, 75, 90 and 125 DAS ranged in between 0.29-0.51, 0.34-0.44,

0.38-0.46, 0.29-0.46 cm, respectively [Table-7].

On squares the minimum width of the first, second, third and fourth instar larvae of *S. litura* was 0.03, 0.05, 0.12 and 0.29 cm on Rasi-665 BG-II cotton hybrids in between 60 and 125 DAS, at seven days after release. The width was decreased from 60 to 75 DAS. Whereas, increased later stages of the crop. The reason behind this is Cry protein expression was highest at 75 DAS in maximum hybrids. So the growth of the larvae also suppressed at the time of 75 DAS compared to 60, 90 and 125 DAS. Compared to leaves the width of the larvae was less on squares. Among all the instars on squares the width of the second instar was reduced drastically.

**Table-6** Effect of test hybrid squares on width of first and second instar larvae of *S. litura*.

Treatments	Width of first instar larvae (cm)				Width of second instar larvae (cm)			
	60 DAS	75 DAS	90 DAS	125 DAS	60 DAS	75 DAS	90 DAS	125 DAS
Ankur-3034	0.03 (1.02) <sup>a</sup>	0.03 (1.02) <sup>a</sup>	0.04 (1.02) <sup>a</sup>	0.03 (1.02) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.09 (1.04) <sup>a</sup>	0.06 (1.03) <sup>a</sup>
Ajeet-155	0.05 (1.03) <sup>a</sup>	0.04 (1.02) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.04 (1.02) <sup>a</sup>	0.09 (1.04) <sup>a</sup>	0.10 (1.05) <sup>a</sup>	0.12 (1.06) <sup>a</sup>	0.09 (1.05) <sup>a</sup>
Chetak	0.04 (1.02) <sup>a</sup>	0.04 (1.02) <sup>a</sup>	0.05 (1.03) <sup>a</sup>	0.04 (1.02) <sup>a</sup>	0.08 (1.04) <sup>a</sup>	0.07 (1.03) <sup>a</sup>	0.09 (1.04) <sup>a</sup>	0.06 (1.03) <sup>a</sup>
ATM	0.04 (1.02) <sup>a</sup>	0.03 (1.02) <sup>a</sup>	0.04 (1.02) <sup>a</sup>	0.04 (1.02) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.07 (1.03) <sup>a</sup>	0.06 (1.03) <sup>a</sup>
Bhakti	0.05 (1.03) <sup>a</sup>	0.03 (1.02) <sup>a</sup>	0.04 (1.02) <sup>a</sup>	0.04 (1.02) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.07 (1.03) <sup>a</sup>	0.08 (1.04) <sup>a</sup>	0.07 (1.03) <sup>a</sup>
Brahma	0.07 (1.03) <sup>a</sup>	0.04 (1.02) <sup>a</sup>	0.05 (1.03) <sup>a</sup>	0.04 (1.02) <sup>a</sup>	0.07 (1.04) <sup>a</sup>	0.07 (1.03) <sup>a</sup>	0.08 (1.04) <sup>a</sup>	0.06 (1.03) <sup>a</sup>
Denim	0.04 (1.02) <sup>a</sup>	0.04 (1.02) <sup>a</sup>	0.04 (1.02) <sup>a</sup>	0.04 (1.02) <sup>a</sup>	0.07 (1.04) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.07 (1.03) <sup>a</sup>	0.06 (1.03) <sup>a</sup>
Rasi-665	0.04 (1.02) <sup>a</sup>	0.03 (1.02) <sup>a</sup>	0.04 (1.02) <sup>a</sup>	0.03 (1.02) <sup>a</sup>	0.07 (1.04) <sup>a</sup>	0.05 (1.03) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.06 (1.03) <sup>a</sup>
Rasi-668	0.04 (1.02) <sup>a</sup>	0.05 (1.02) <sup>a</sup>	0.05 (1.02) <sup>a</sup>	0.03 (1.02) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.09 (1.04) <sup>a</sup>	0.05 (1.03) <sup>a</sup>
Sudarshan	0.05 (1.03) <sup>a</sup>	0.03 (1.02) <sup>a</sup>	0.04 (1.02) <sup>a</sup>	0.04 (1.02) <sup>a</sup>	0.09 (1.04) <sup>a</sup>	0.08 (1.04) <sup>a</sup>	0.08 (1.04) <sup>a</sup>	0.08 (1.04) <sup>a</sup>
Yuva	0.03 (1.02) <sup>a</sup>	0.05 (1.02) <sup>a</sup>	0.04 (1.02) <sup>a</sup>	0.03 (1.02) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.07 (1.03) <sup>a</sup>	0.06 (1.03) <sup>a</sup>
Control	0.04 (1.02) <sup>a</sup>	0.04 (1.02) <sup>a</sup>	0.04 (1.02) <sup>a</sup>	0.05 (1.03) <sup>a</sup>	0.07 (1.04) <sup>a</sup>	0.08 (1.04) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.09 (1.04) <sup>a</sup>
CD	0.01	0	0.01	0.002	0.01	0.01	0.01	0.01
SE(m)	0.002	0	0.002	0.001	0.002	0.003	0.004	0.002

Figures in parentheses are square root transformed values; numbers followed by same superscript are not statistically different.

**Table-7** Effect of test hybrid squares on width of third and fourth instar larvae of *S. litura*.

Treatments	Width of third instar larvae (cm)				Width of fourth instar larvae (cm)			
	60 DAS	75 DAS	90 DAS	125 DAS	60 DAS	75 DAS	90 DAS	125 DAS
Ankur-3034	0.15 (1.07) <sup>a</sup>	0.17 (1.08) <sup>a</sup>	0.17 (1.08) <sup>a</sup>	0.15 (1.07) <sup>a</sup>	0.46 (1.21) <sup>ab</sup>	0.43 (1.20) <sup>a</sup>	0.38 (1.18) <sup>a</sup>	0.33 (1.15) <sup>ab</sup>
Ajeet-155	0.22 (1.10) <sup>a</sup>	0.21 (1.10) <sup>a</sup>	0.24 (1.11) <sup>a</sup>	0.19 (1.09) <sup>a</sup>	0.50 (1.23) <sup>ab</sup>	0.34 (1.16) <sup>a</sup>	0.44 (1.20) <sup>a</sup>	0.43 (1.19) <sup>b</sup>
Chetak	0.16 (1.08) <sup>a</sup>	0.18 (1.09) <sup>a</sup>	0.18 (1.09) <sup>a</sup>	0.18 (1.09) <sup>a</sup>	0.42 (1.19) <sup>ab</sup>	0.41 (1.19) <sup>a</sup>	0.45 (1.20) <sup>a</sup>	0.29 (1.14) <sup>ab</sup>
ATM	0.15 (1.07) <sup>a</sup>	0.24 (1.11) <sup>a</sup>	0.17 (1.08) <sup>a</sup>	0.18 (1.09) <sup>a</sup>	0.36 (1.17) <sup>ab</sup>	0.38 (1.18) <sup>a</sup>	0.42 (1.19) <sup>a</sup>	0.39 (1.18) <sup>ab</sup>
Bhakti	0.15 (1.07) <sup>a</sup>	0.15 (1.07) <sup>a</sup>	0.16 (1.08) <sup>a</sup>	0.18 (1.09) <sup>a</sup>	0.46 (1.21) <sup>ab</sup>	0.41 (1.19) <sup>a</sup>	0.43 (1.20) <sup>a</sup>	0.38 (1.17) <sup>ab</sup>
Brahma	0.18 (1.09) <sup>a</sup>	0.18 (1.09) <sup>a</sup>	0.17 (1.08) <sup>a</sup>	0.18 (1.09) <sup>a</sup>	0.45 (1.20) <sup>ab</sup>	0.36 (1.17) <sup>a</sup>	0.44 (1.20) <sup>a</sup>	0.36 (1.16) <sup>ab</sup>
Denim	0.16 (1.08) <sup>a</sup>	0.16 (1.08) <sup>a</sup>	0.18 (1.09) <sup>a</sup>	0.19 (1.09) <sup>a</sup>	0.51 (1.23) <sup>a</sup>	0.42 (1.19) <sup>a</sup>	0.45 (1.20) <sup>a</sup>	0.41 (1.19) <sup>ab</sup>
Rasi-665	0.13 (1.07) <sup>a</sup>	0.12 (1.06) <sup>a</sup>	0.12 (1.06) <sup>a</sup>	0.20 (1.10) <sup>a</sup>	0.29 (1.13) <sup>ab</sup>	0.38 (1.18) <sup>a</sup>	0.42 (1.19) <sup>a</sup>	0.39 (1.18) <sup>ab</sup>
Rasi-668	0.15 (1.07) <sup>a</sup>	0.17 (1.08) <sup>a</sup>	0.26 (1.12) <sup>a</sup>	0.16 (1.08) <sup>a</sup>	0.34 (1.16) <sup>ab</sup>	0.38 (1.18) <sup>a</sup>	0.43 (1.20) <sup>a</sup>	0.38 (1.18) <sup>ab</sup>
Sudarshan	0.21 (1.10) <sup>a</sup>	0.25 (1.12) <sup>a</sup>	0.28 (1.13) <sup>a</sup>	0.27 (1.14) <sup>a</sup>	0.48 (1.22) <sup>ab</sup>	0.44 (1.20) <sup>a</sup>	0.46 (1.21) <sup>a</sup>	0.46 (1.21) <sup>ab</sup>
Yuva	0.15 (1.07) <sup>a</sup>	0.15 (1.07) <sup>a</sup>	0.16 (1.08) <sup>a</sup>	0.25 (1.12) <sup>a</sup>	0.48 (1.22) <sup>ab</sup>	0.42 (1.19) <sup>a</sup>	0.43 (1.19) <sup>a</sup>	0.43 (1.20) <sup>ab</sup>
Control	0.26 (1.12) <sup>a</sup>	0.24 (1.11) <sup>a</sup>	0.21 (1.10) <sup>a</sup>	0.31 (1.15) <sup>a</sup>	0.49 (1.22) <sup>ab</sup>	0.47 (1.21) <sup>a</sup>	0.48 (1.22) <sup>a</sup>	0.51 (1.23) <sup>a</sup>
CD	0.02	0.01	0.02	0.02	0.02	0.02	0.03	0.02
SE(m)	0.01	0.004	0.01	0.01	0.01	0.01	0.01	0.01

Figures in parentheses are square root transformed values; numbers followed by same superscript are not statistically different.



## Bolls

In case of second instar larvae the width at 90 and 125 DAS ranged in between 0.04-0.12 and 0.04-0.08 cm, respectively. The width of third instar larvae fed with bolls of eleven BG-II cotton hybrids at 90 and 125 DAS ranged in between 0.13-0.23 and 0.17-0.29 cm, respectively. The width of fourth instar larvae fed with squares of eleven BG-II cotton hybrids recorded at 90 and 125 DAS ranged in between 0.36-0.46 and 0.38-0.55 cm, respectively [Table-8].

On bolls the minimum width of the second, third and fourth instar larvae of *S. litura* was 0.06, 0.14 and 0.36 cm. Among all the eleven hybrids the width was decreased on Rasi-665 hybrid. But overall the width was increased from 90 to 125 DAS. The reason behind this is Cry protein expression was decreased while the age of the crop was increased, so the width was increased from 90 to 125 DAS. The growth of the larvae was suppressed at the time of 90 DAS old crop

compared to 125 DAS old crop.

Similar work was done by [10], who observed that there is a reduction in the mean larval width of larvae and developmental time was prolonged in the larvae fed on Bollgard-II leaves. [12] conducted leaf assays in the laboratory indicate that Bollgard-II cotton inhibit the growth of *H. zea*, *H. virescens*, *S. frugiperda*, *S. exigua*, and *P. includes* than Cry 1 Ac only and non-Bt cotton.

The length of the larvae fed on Rasi-665 BG-II squares was minimum with less width in all the three instars viz., second, third and fourth instars tested. The Rasi-665 BG-II hybrid was superior over the other hybrids tested in having less preference for feeding by *S. litura*. The Rasi-665 BG-II hybrids was resistant to *S. litura* attack and therefore the length and width of larvae fed on leaves, squares and bolls of this hybrid was low compared to other test hybrids and it is statistically superior over other test hybrids.

**Table-8** Effect of test hybrid bolls on larval width of *S. litura*.

Treatments	Width of second Instar larvae (cm)		Width of third Instar larvae (cm)		Width of fourth Instar larvae (cm)	
	90DAS	125DAS	90DAS	125DAS	90DAS	125DAS
Ankur-3034	0.05 (1.03) <sup>a</sup>	0.07 (1.03) <sup>a</sup>	0.19 (1.09) <sup>a</sup>	0.17 (1.08) <sup>a</sup>	0.38 (1.17) <sup>a</sup>	0.53 (1.24) <sup>a</sup>
Ajeet-155	0.07 (1.03) <sup>a</sup>	0.08 (1.04) <sup>a</sup>	0.23 (1.11) <sup>a</sup>	0.19 (1.09) <sup>a</sup>	0.44 (1.20) <sup>a</sup>	0.55 (1.24) <sup>a</sup>
Chetak	0.12 (1.06) <sup>a</sup>	0.07 (1.03) <sup>a</sup>	0.15 (1.07) <sup>a</sup>	0.19 (1.09) <sup>a</sup>	0.4 (1.18) <sup>a</sup>	0.48 (1.22) <sup>a</sup>
ATM	0.05 (1.02) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.16 (1.08) <sup>a</sup>	0.18 (1.09) <sup>a</sup>	0.41 (1.19) <sup>a</sup>	0.53 (1.24) <sup>a</sup>
Bhakti	0.08 (1.04) <sup>a</sup>	0.05 (1.03) <sup>a</sup>	0.17 (1.08) <sup>a</sup>	0.18 (1.09) <sup>a</sup>	0.4 (1.18) <sup>a</sup>	0.52 (1.23) <sup>a</sup>
Brahma	0.08 (1.04) <sup>a</sup>	0.05 (1.03) <sup>a</sup>	0.17 (1.08) <sup>a</sup>	0.19 (1.09) <sup>a</sup>	0.43 (1.20) <sup>a</sup>	0.42 (1.19) <sup>a</sup>
Denim	0.07 (1.03) <sup>a</sup>	0.08 (1.04) <sup>a</sup>	0.16 (1.08) <sup>a</sup>	0.26 (1.13) <sup>a</sup>	0.54 (1.24) <sup>a</sup>	0.44 (1.28) <sup>a</sup>
Rasi-665	0.06 (1.03) <sup>a</sup>	0.04 (1.02) <sup>a</sup>	0.14 (1.07) <sup>a</sup>	0.17 (1.08) <sup>a</sup>	0.36 (1.17) <sup>a</sup>	0.45 (1.20) <sup>a</sup>
Rasi-668	0.1 (1.05) <sup>a</sup>	0.04 (1.02) <sup>a</sup>	0.13 (1.06) <sup>a</sup>	0.19 (1.09) <sup>a</sup>	0.45 (1.20) <sup>a</sup>	0.38 (1.18) <sup>a</sup>
Sudarshan	0.05 (1.02) <sup>a</sup>	0.05 (1.02) <sup>a</sup>	0.17 (1.08) <sup>a</sup>	0.29 (1.14) <sup>a</sup>	0.46 (1.21) <sup>a</sup>	0.54 (1.24) <sup>a</sup>
Yuva	0.04 (1.02) <sup>a</sup>	0.06 (1.03) <sup>a</sup>	0.16 (1.08) <sup>a</sup>	0.27 (1.13) <sup>a</sup>	0.38 (1.18) <sup>a</sup>	0.44 (1.20) <sup>a</sup>
Control	0.06 (1.03) <sup>a</sup>	0.05 (1.02) <sup>a</sup>	0.18 (1.09) <sup>a</sup>	0.33 (1.15) <sup>a</sup>	0.44 (1.20) <sup>a</sup>	0.54 (1.24) <sup>a</sup>
CD	0.01	0.01	0.02	0.02	0.03	0.03
SE(m)	0.002	0.002	0.01	0.01	0.01	0.01

Figures in parentheses are square root transformed values; numbers followed by same superscript are not statistically different

## Conclusion

Laboratory experiment was conducted to know the length and width of the *S. litura* on eleven BG-II cotton hybrids. Length and width was decreased on all the BG-II cotton hybrids. Whereas, Rasi-665 is the good one to control the *S. litura* larvae within the eleven Bg-II hybrids. The length and width also decreased upto 90DAS of the crop only later the plant parts didn't show much effect on the larvae of *S. litura*.

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